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POWER QUALITY ANALYSIS

METREL®

PowerQ *Plus*
PowerQ
Power Quality Analyser Plus
Power Harmonics Analyser
Power Monitor
VoltScanner
Power Simulator

Multifunctional Power Quality Analysers

There are quite a few reasons for measuring and analysing power quality nowadays. Our work mostly depends on computers and machines supplied by electrical power. Therefore, problems with electrical power directly impact our work.
What is a power quality problem? This is every deviation of the electricity applied to the equipment which results in damage or misoperation of electronic equipment or other electrical devices.

Some common symptoms of power quality problems in facilities are:

- Unexplained equipment trips or shutdowns.
- Occasional equipment damage or component failure.
- Erratic control of process performance.
- Random lockups and data errors.
- Power system component overheating.

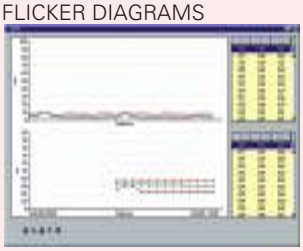
If we look at those technical problems from the economic point of view, this means that we have to deal with decreased production, time delays, additional expenses and company reputation. Therefore good power quality is a must for a normal business flow. Metrel Power Quality Analyser product line will help you find many problems on your site such as:

- Identification of sensitive electrical devices.
- Early detection of potential errors.
- Electrical network optimization or expansion on power quality measurements basis.

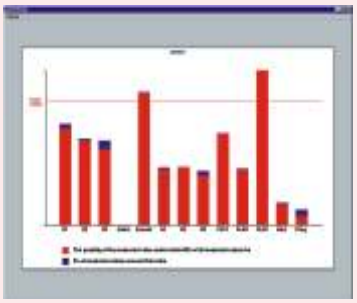
Metrel instruments are easy to use and housed in durable cases, designed for rough environment. They have outstanding price/performance ratio.

Typical applications of individual instruments

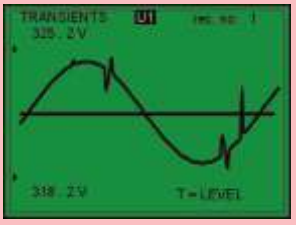
FLICKER DIAGRAMS

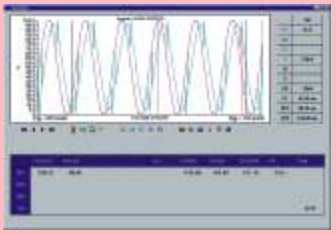


STATISTICS REPORTS

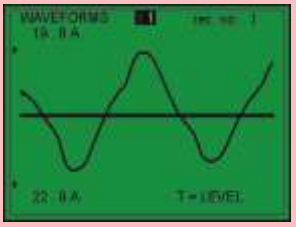


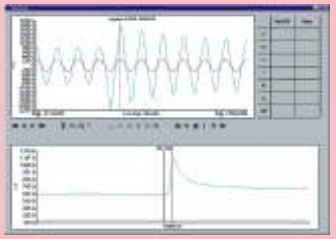
Power quality assessment according to EN 50160 and flicker measurement performed with **MI 2292 Power Quality Analyser Plus.**



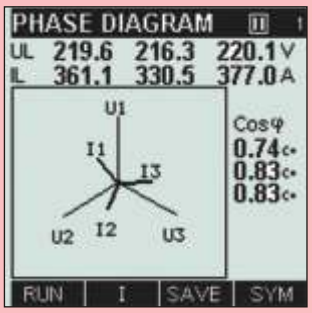


Transients capturing with **MI 2292 Power Quality Analyser Plus.** Transients can appear due to atmosphere discharges, switching maneuvers or capacitor banks switching. Records can be effectively used for overvoltage protection selection.





Waveform analysis performed either with **MI 2292 Power Quality Analyser Plus.** Useful feature for determining harmonics direction, UPS performance evaluation or motor start-up analysis.



Different pre-set loggers within **MI 2392 PowerQ** [Plus] allow quick on-site power quality assessment without the need to download recorded data on a PC. Examples show phase diagram which helps when connecting the instrument to power supply network U, I, f logger is a useful feature for measurement conditions evaluation.

Periodic measurement of basic power quality parameters (U,I, P, Q, S, PF, etc.) with harmonics analysis performed with **MI 2092 Power Harmonics Analyser.**

Comparison table	Power Quality Analyser-Plus	Power Harmonics Analyser	PowerQ Plus	PowerQ	VoltScanner	Power Monitor
Main features Part No.:	**MI 2292**	**MI 2092**	**MI 2392**	**MI 2492**	**MI 2130**	**MI 4100**
Power Quality Testing						
RMS Voltages, Currents (average, min., max.)	✓	✓	✓	✓	✓ (voltage only)	✓ (min, max only)
Harmonics Analysis THD	✓	✓	✓	✓		✓
Power Active, Reactive, Apparent Cos φ Character, sign	✓	✓	✓	✓		✓
Voltage Events (dips, sags, interruptions)	✓	✓	✓		✓	✓
Logger (U, I, P, Q, S)	✓	✓	✓	✓	✓	✓ (P, Q, S, only)
Periodic Analysis	✓	✓	✓	✓	✓	✓
Statistical Analysis	✓	✓			✓	
Anomalies (Events) Analysis	✓	✓	✓		✓	✓
Neutral current (calculated)	✓	✓	✓	✓		✓
On line monitoring						
Meter mode - tabelaric results	✓	✓	✓	✓		✓
Scope mode - oscilloscope	✓	✓	✓	✓		
Spectrum Analysis mode	✓	✓	✓	✓		✓
EN 50160 compliant testing						
Fast Set Up - Auto mode	✓		✓		✓	
Voltage	✓	✓	✓		✓	
THD & Harmonics	✓	✓	✓			
Dips, Sags, Interruptions	✓	✓	✓		✓	
Flicker	✓					
Frequency	✓	✓	✓		✓	
Interharmonics / Signaling	✓					
Unbalance	✓		✓			
EN 50160 Test Report	✓		✓			
Special tools						
Fast logging mode/inrush current	✓ (166 minutes)		-/✓			
Waveform mode	✓ (7812 periods)		✓ (10 per.)	✓ (10 per.)		
Transient mode	✓ (1000 periods)				✓	
Energy						
Total & Subtotal counters	✓	✓	✓	✓		✓
Other						
PC Software	✓	✓	✓	✓		✓
Modem entrance key	✓	Optional				

	Typical application areas	Possible corrective solutions	Suitable Metrel Power Quality Analyser
General Power Quality Testing	- General power quality assessment - Power factor correction - Harmonics filtering - Power peak reduction - Power breaks capturing	- PF correction equipment - Filters - UPS - Power conditioners	- Power Harmonics Analyser MI 2092 - Power Quality Analyser Plus MI 2292 - PowerQ Plus MI 2392 - PowerQ MI 2492
EN 50160 Voltage Quality Evaluation	- Assessment of supply voltage quality at end users - Assessment of voltage quality at end users - Assessment of voltage quality in electrical generation systems	- Dealing with customer complaints - UPS - Ferro-resonant transformers - Backup generators - Power conditioners	- Voltscanner MI 2130 (1-phase only) - Power Quality Analyser Plus MI 2292 - PowerQ Plus MI 2392
Waveforms Recording	- Analysis of influences of motor start-ups - Analysis of load variations - Analysis of non-linear loads	- Voltage regulators - Power conditioners - UPS - Ferro-resonant transformers - Filters	- Power Quality Analyser Plus MI 2292 - PowerQ Plus MI 2392 - PowerQ MI 2492
Transients Capturing	- Analysis of oscillatory transients caused by lightning - Analysis of electrostatic discharges - Analysis of switching manouvres	- UPS - Overvoltage protection devices - Analysis of switching manouvres	- Power Quality Analyser Plus MI 2292
Fast Logging Recording	- Analysis of influences of motor start-ups - Analysis of load variations	- Voltage regulators - Power conditioners - UPS	- Power Quality Analyser Plus MI 2292 - PowerQ Plus MI 2392

PowerQ *Plus* and PowerQ

Advanced, handheld, easy to use 3-phase power quality analysers

- First 3-phase power quality instruments on the market that meet the following criteria:
- PowerQ *Plus* and PowerQ are genuine, portable 3-phase power quality analysers which favorably compete with higher priced instruments and can be easily implemented in a variety of different situations.
- Large number of measurements and number of loggers suited for routine or complex power quality assessment in heavy duty industrial environments.
- All data can be evaluated directly on the instrument; there is no need to carry a PC on field.
- Advanced power quality functions: inrush current, voltage events and EN 50160 reporting. (only MI 2392)
- Pre-set logging screens allow on-site evaluation of all major power quality parameters (U,I, P, PF, cos φ, THD, individual harmonics components, phase shifts, etc.).
- Windows compatible PowerQ Link software package expands the versatility of PowerQ *Plus* / PowerQ and allows transfer of stored data to a computer.
- PowerQ *Plus* and PowerQ can be manipulated by one hand, leaving the other hand free for tools.

Target applications

- Power quality assessment and troubleshooting in low and middle voltage electrical systems.
- Checking power correction equipment performance.
- Harmonics spectrum analysis for selection of harmonic filters.
- UPS, voltage generators and regulators checking and troubleshooting.
- Voltage, current, power monitoring and recording.
- Energy consumption monitoring and recording.
- Network power quality evaluation according to EN 50160. (only MI 2392)

Main features

- Simultaneous analysis of basic power quality parameters (U, I, P, Q, S, PF).
- Harmonics analysis up to 50th component.
- Phase diagram and unbalance calculation for 3-phase systems.
- Voltage and current on-line scope function.
- Instrument is ready for incoming A 1179 flex clamps.
- Voltage events (dip, swells and interrupts) evaluations.
- Recording and reporting according to EN 50160. (only MI 2392)

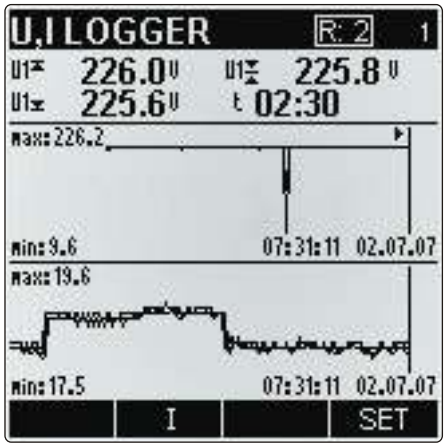
USB and **RS-232** interface

Technical specification - PowerQ *Plus* and PowerQ

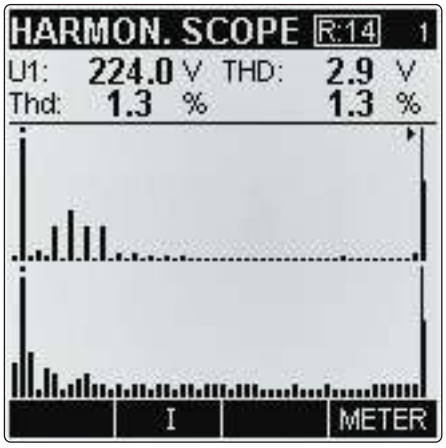
Voltage and current	
Three phase AC/DC voltage input	
Sampling frequency:	5120 Hz
Resolution:	4 digits
Frequency range:	45 ÷ 66 Hz
Input voltage range:	3 ÷ 550 V_{RMS} L-N
Input voltage range:	3 ÷ 550 V_{RMS} L-L
Accuracy:	1%
Crest factor:	<1.4 @ 550 V_{RMS}
Three phase AC/DC current inputs for connection to current transducers with voltage output.	
Current ranges for :	A 1033 (1000 A) clamps
Range 10 % IN:	4 A ÷ 100 A
Range 100 % IN:	40 A ÷ 1000 A
Crest factor:	< 2,3 @ 1000 A
Current ranges for :	A1122 (5 A) clamps
Range 10 % IN:	5 mA ÷ 500 mA
Range 100 % IN:	50 mA ÷ 5 A
Ideally for indirect current measurement form 1A/1A to 10kA/5A ratio.	

Active, reactive and apparent power	
Measurements are performed in four quadrants: load or generator with capacitive or inductive character	
Resolution:	4 digits
Pow. range:	1÷ 40000 MW, MVAr, MVA
Energy range:	1÷ 40000 MWh, MVArh
Pow. accuracy:	(3% + 3 dig)
Power factor, cos measurement.	
Voltage and current harmonics	
Measure up to 50th harmonic, with 200ms rectangular time window.	
Voltage events and power quality	
VRMS (½) measurements for voltage events evaluation, according to EN 61000-4-30.	
Interval: selectable	1 ÷ 10 min
Recording period:	up to 1 week
EN 50160 reporting on LCD screen	

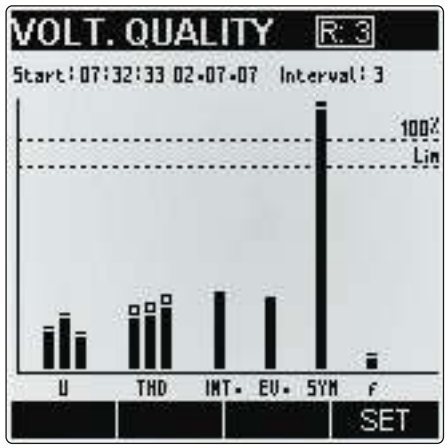
PowerQ Displays



U,I logger screen

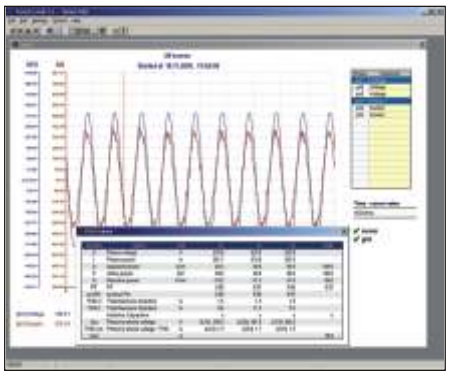


Harmonics screen

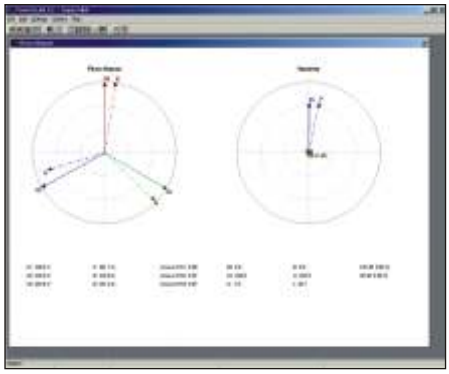


EN 50160 screen

PowerQ Link Displays



UIf scope screen



Phase diagram

Harmonics screen

Voltage quality

Ordering information

Standard Set Part No. **MI 2392, MI 2492**

- Instrument PowerQ ^{Plus} or PowerQ
- Current clamp 1000 A/1 V, 3 pcs
- Test tips, 3 pcs
- Alligator clips, 4 pcs
- Voltage measurement cables, 4 pcs
- PC SW Package PowerQ Link on CD with RS 232 cable and USB cable
- Power supply adapter
- Rechargeable batteries, 6 pcs
- Soft carrying bag
- Instruction manual
- Handbook "Modern Power Quality Measurement Techniques" on CD
- Product verification data

Optional accessories

A 1020 - Small soft carrying bag
A 1037 - Three-phase current transformer 5 A/1 V
A 1039 - Clamp adapter
A 1069 - Mini current clamp 100 A /1 V
A 1099 - Single-phase flex, current clamp 3000 A /1 V
A 1120 - Three-phase flex, current clamp 3000 A /1 V
A 1122 - Mini current clamp 5 A /1 V
S 2014 - Safety fuse adapters
S 2015 - Safety flat clamps

Loggers
Record: up to 75 hour UIf, power and THD logging and up to 168 hour in EN 50160 with 10 min interval
Display and store: min., avg., and max. value of the interval
Voltage and current logger
Signals: selectable: U1, U2, U3, I1, I2, I3
Interval: selectable 1 second ÷ 30 minutes
Power logger
Signals: selectable L1, L2, L3, TOT
Interval: selectable 1 second ÷ 30 minutes
Displayed data: min., average and max. value
Four quadrant logger
Harmonics logger
Signals: selectable THDI1/2/3; THDU1/2/3
Interval: selectable 1 second ÷ 30 minutes
Displayed data: min., average and max. value of the interval
Inrushes
Signals: selectable U1, U2, U3, I1, I2, I3
Interval: selectable: 10÷200 ms
Trigger level: selectable, 2 % ÷ 100 % of current range

General

Working temperature range:	-10 °C ÷ +55 °C
Max. Humidity:	95 % RH (0 °C ÷ 40 °C), non-condensing
Pollution degree:	2
Protection classification:	double insulation
Overvoltage category:	voltage inputs: CAT III 600 V
Protection degree:	IP 42
Display:	graphic liquid crystal display with backlight 160x160 dots
External DC supply:	12 V, 400 mA min.
Maximum power consumption:	360 mA
Communication:	RS 232 serial interface and USB
Baud rate:	2400 bps ÷ 115200 bps
Connector:	9 pin D-type and USB-B
Dimensions:	(220 x 115 x 90) mm
Weight (without accessories):	0.65 kg

Power Quality Analyser Plus

Power Quality Analyser Plus MI 2292

- Metrel´s top of the range three- phase, multifunction power quality analyser with a complete selection of test functions and diagnostic tools for wide range of applications.
- Automatic EN 50160 power quality assessment test.
- Flicker measurement in accordance with EN 50160.
- Modem communication support for remote control of the instrument.
- Measurements according to IEC / EN 61000-4-30.
- Recording of short-period events like transients, inrush currents, resonant states, switchings, etc.
- Harmonics direction determination.
- Optional: 110 V version.

Power Harmonics Analyser MI 2092

- Three-phase, multifunction power quality analyser suitable for performing all the most frequent measurements and diagnostics in different electrical systems.
- Optional remote modem communication support.
- Optional: 110 V version.

Modem Remote Control by using GSM or standard type of telephone communication.

Technical specification

AC VOLTAGES

Three-phase AC voltage input (3 differential inputs, L_1 - N_1, L_2 - N_2, L_3 - N_3)

Input voltage range:	10–550 V_{rms} L-N, 900 V_{rms} L-L
	600 V_{rms} L-N (overload 10 s)
Optional on request:	10–750 V_{rms} L-N, 1000 V_{rms} L-L
	800 V_{rms} L-N (overload 10 s)
Resolution:	0.1 V
Accuracy:	± 0.5 % of reading ± 2 digits
Crest factor max.:	1...1.4 @ 550 V_{rms} L-N
Frequency range:	43–68 Hz fundamental

AC CURRENTS

Three-phase AC input for connection to current transducers with voltage output

Input current (voltage range):	0.02–1 V_{rms} (from 0.02 x I_n to I_n) input
Resolution:	0.3 mV (0.3 A with 1000 A / 1 V)
Accuracy:	± 0.5 % of reading ± 6 digits plus current transformer accuracy
Crest factor:	1...2.5 @ 1 V_{RMS}
Maximum permissible overload:	150 % I_n (sinusoidal current)
Maximum input voltage:	1 V_{rms}

PHASE ANGLE

Consider phase angle data of current transformer used.

SCOPE

Display options:	Waveform of pairs (L_1: U_1 and I_1, L_2: U_2 and I_2, L_3: U_3 and I_3), $U_{1,2,3}$, and $I_{1,2,3}$
Ranging:	Auto / manual

METER – Power measurement

Quantities related to selected measuring connections per phase, i.e.:

Measured:	voltage (U), current (I), cosφ between U and I
Calculated:	active power (P), apparent power (S), reactive power (Q), power factor (Pf) with its characteristics (c, I, none)
	Line – Line voltage;

Quantities for complete three-phase system, i.e.:

Calculated:	active power (Pt), apparent power (St), reactive power (Qt), power factor (Pft), neutral current (In);
Basic accuracy for P, Q, S,:	± 1 % of reading
Resolution for P, Q, S,:	0.01 of displayed value

SPECTRUM – Harmonics measurement

The instrument computes harmonics on signals sampled with an A/D converter.

Recording interval:	160 ms (8 cycles)
Spectrum calculation range:	DC – 63rd
Spectrum display range:	DC – 25th

Displayed items for selected harmonic: Order, relative and absolute value

Range	Limits of error		Resolution
I_{range} U_{range}	THD Total Harmonic Distortion	HD Harmonic Distortion	on LCD and PC
2 ...100 %	0.2 % x U_r/U (I_r/I)	0.2 % x U_r/U (I_r/I)	0.1 %

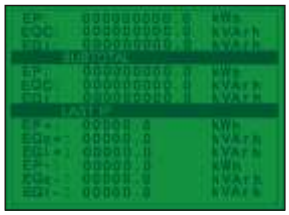
ENERGY

Displayed quantities from integration of calculated power as:
– cumulative values (TOTAL);
– partly cumulative (resettable by user request) (SUBTOTAL);
– values related to last integration period (LAST IP).

Quantities. Active energy (EP), capacitive energy (EQC), inductive energy (EQI)

Basic accuracy:	± 1 % of reading
Resolution:	0.1 of displayed value

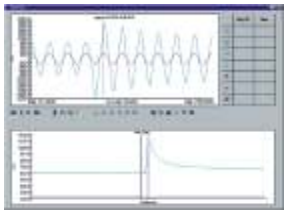
Power Harmonics Analyser



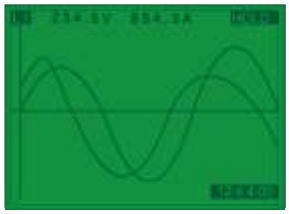
Energy Measurement
Active & Reactive
Import & Export
Inductive & Capacitive.
Separate registers for Total, Sub-total & Last Integration Period

Voltage and Current Harmonic Analysis up to 63rd component

True Real Time operation for voltage interrupts and power break capturing **2 MB of memory** allow data logging up to several months.



Waveform analysis



Scope function allows monitoring of current and voltage

Configuration menu for setting the measuring method, integration period, current scaling factor and selection of signals.

Ordering information

Standard Set Part No. **MI 2292**

- Instrument MI 2292 PQA Plus or MI 2092 PHA
- Current clamp 1000 A/1V, 3 pcs
- Small soft carrying bag for current clamps
- Test tip, red; 3 pcs
- Safety flat clamps, 4 pcs
- Alligator clip, black; 4pcs
- Voltage measurement cables; 6 pcs
- Mains cable
- RS 232 cable
- 4 × 1,2 V NiMH batteries
- Power Link PC analysis and control SW package
- Soft carrying bag
- Instruction manual
- Handbook "Modern Power Quality Measurement Techniques" on CD
- Product verification data

Standard Set Part No. **MI 2092**

- Standard Set Part No. MI 2292 (with safety flat clamps S 2015)

Optional accessories

A 1037 - Three-phase current transformer 5 A/1 V
A 1039 - Clamp adapter
A 1069 - Mini current clamp 100 A /1 V
A 1099 - Single-phase flex, current clamp 3000 A /1 V
A 1100 - Modem ST
A 1101 - Modem GSM
A 1120 - Three-phase flex, current clamp 3000 A /1 V
A 1122 - Mini current clamp 5 A /1 V
A 1124 - Modem Entrance Key (MI 2092)
A 1171 - USB/RS232 converter with 1 m fixed cable
S 2014 - Safety fuse adapters
S 2015 - Safety flat clamps

RECORDER
Periodics integration period: 1 s – 900 s
Selected signals: max. 64
Statistics values: each period divided in 200 parts (0.1 ms)
Voltage anomalies: based on half period, start, duration and extremes of voltage
EN 50160 ANALYSIS MODE (MI 2292 and MI 2192)
Voltage dips, swells, sags and breaks, resolution 10 ms, no gaps
Voltage unsimetry, Voltage RMS values, Frequency
Harmonics: up to 43rd component
Flickers Plt Pst: no gap

FLICKER MEASUREMENT
The instrument computes flickers according to IEC 61000-4-15 (MI 2292 only)

WAVEFORMS
Sampling rate: 128 scans / period (MI 2292 - 7812 periods, MI 2192 - 390 periods)
Trigger: level, manual, timer
Buffer: min. 10 periods of pre / post size, up to 7812 periods can be recorded
Channels: 3 x U, 3 X I, U lines, Min / Max rms values: Avg
Pf, cosφ, Crest factor, THD U, I Frequency
Harmonics / direction: magnitudes / positive / negative

FAST LOGGING
Sampling rate: 128 scans / period, min, max, avg recorded each half period
Trigger: level, manual, timer
Buffer: pre / post size, up to 166 minutes of recording
Channels: 3 x U, 3 X I, Single or multi channel mode

TRANSIENTS
Capturing: >20 µs transient detectability
Trigger: Level, slope, manual
Buffer: min. 10 periods of pre / post size, up to 1000 periods can be recorded
Channels: 3 x U, 3 X I, single or multi channel mode

General
Display: Graphic Liquid Crystal Display with LED backlight, 160 x 116 dots resolution

NON – VOLATILE MEMORY
2048 Kbytes SRAM, battery backed.

DIGITAL HARDWARE SPECIFICATION
A/D conversion, 14 bit with 128 samples per channel per period (43–68 Hz).

OUTPUTS
Communication type: RS 232 serial interface, fully opto isolated
Baud rate: 2400–57600 bps
Connector: 9 pin D-type.
Communication cable: Standard type

POWER SUPPLY
Operating range: 230 V A.C. +10 % – 20 %, 45–65 Hz, 8 VA
Optional: 115 V A.C. +10 % – 20 %, 45–65 Hz, 8 VA
DC power supply: Internal 4 x 1.2 V NiCd or NiMh rechargeable IEC LR14 batteries provide full operation for up to 5 hours
Charger: Internal built-in battery charger, charging time approx. 10 hours

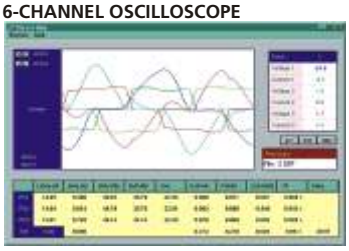
GENERAL
Working temperature range: –20 °C ..+ 60 °C
Max. humidity: 85 % RH (0 ¸ 40 °C)
Pollution degree: 2
Protection classification: II - double insulation
Overvoltage category: Voltage inputs: CAT III 600 V; optional CAT IV 600 V
AC power supply CAT III 300 V
Protection degree: IP 64
Dimensions: 265 x 110 x 185 mm
Weight (without accessories): 2 kg

PowerLink

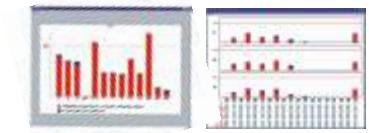
Direct mode

On-line monitoring of three-phase currents and voltages

6-CHANNEL OSCILLOSCOPE



HARMONICS UP TO 63rd



Test Reports

Recorder mode

Simple set-up

– Selection of signals and type of analysis (periodics, anomalies, statistics, EN 50160).
– Selection of recording time and averaging cycles integration period.

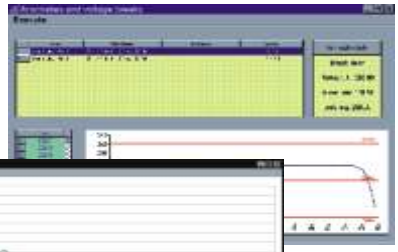
Recording can be set also directly from the instrument.

Analysis

PERIODICS AND STATISTICS ANALYSIS

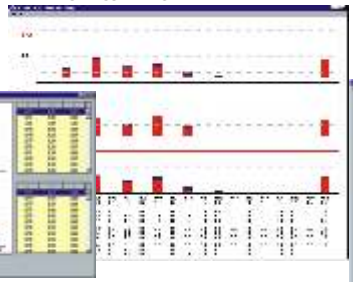
Over 300 quantities (64 simultaneously) can be recorded and stored in this mode. All important quantities and events can be selected:

– average, minimum and maximum voltage and current RMS values,
– harmonics and THD of voltage and current,
– particular and total power (classified sign and character),
– voltage events and anomalies (interruptions, dips, sags), type and duration,
– flicker Pst and Plt values,
– other EN50160 parameters: signaling, interharmonics, unbalances.

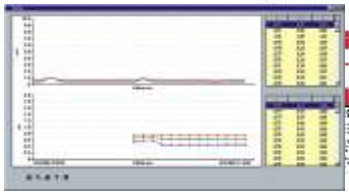


EN 50160 AUTO-MODE with statistics and results based on the standard

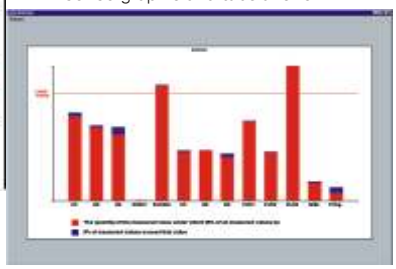
HARMONICS REPORT



FLICKER DIAGRAMS



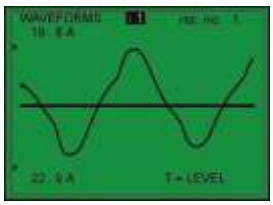
STATISTICS REPORT
in EN 50160 graphic and tabelaric form



– Saving results, graphs and reports for further analysis.
– Exporting data and graphs in xls files for making custom reports.
– Printing out results and graphs.

PC Software

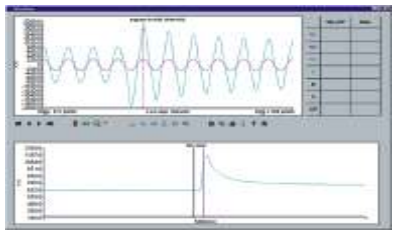
Special tools enable a detailed, time domain based signal analysis. They represent a powerful, modern troubleshooting tool for solving all kinds of problems which appear in power distribution systems. The user can choose between three modes, differing in terms of sampling speed, trigger possibilities and recording time:

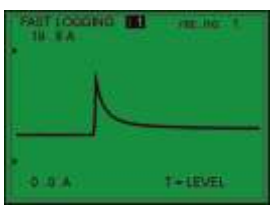


WAVEFORMS

Recording voltages and currents with 128 samples/period. Half period RMS values of recorded quantities are also calculated and shown in this mode. Best suited for:

– monitoring switching phenomena,
– locating noise and disturbance sources,
– defining disturbance type,
– locating excessive harmonics sources.

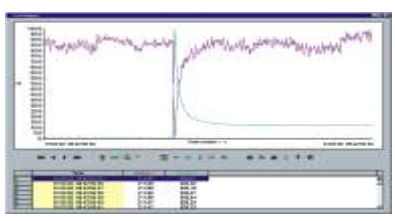


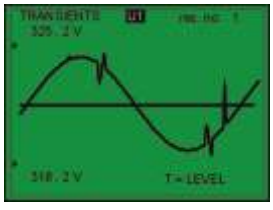


FAST LOGGING OF SIGNALS

Recording half period RMS voltage and current values. Recommended when record length is critical and signal details are not of importance. Best suited for:

– observing start up and inrush events,
– locating impedance problems,
– long term analysing of unstable mains.

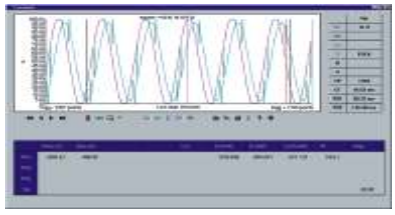


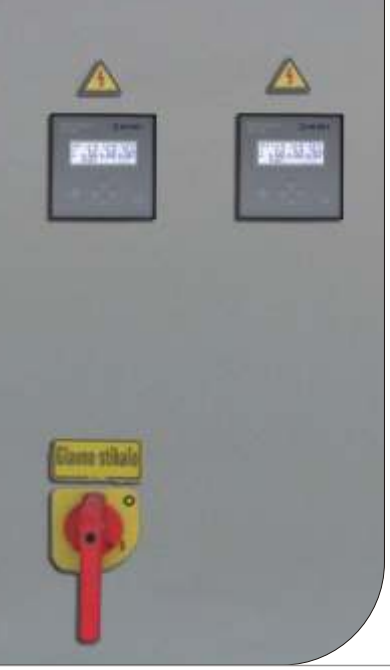


TRANSIENTS

The recording mode with the fastest sampling rate the instrument can provide. Up to 50 kHz transient detectability in this mode. Best suited for:

– monitoring atmospheric discharging,
– analysing switching problems,
– detailed analysis of high frequency noise and notching.





Power Monitor

Power Monitor MI 4100 is a programmable 4-quadrant power and energy meter, which performs accurate single or three phase simultaneous measurements of:

- RMS Voltage,
- RMS Current,
- Harmonic Analysis (up to 31st harmonic component),
- Power and crest factor,
- Power (4-quadrant) energy,
- Energy (active and reactive).

It is equipped with storage memory, 4 opto-isolated inputs and 2 programmable relay outputs. RS-485 and MODBUS interface permit remote reading and control. Due to its compact design and high interference resistance it is suitable for fixed mounting and continuous non supervised operation.

Suitable for:

- Monitoring electrical equipment susceptible to power quality.
- Monitoring critical electrical equipment which can compromise power quality and cause malfunction of sensitive devices.
- Power on demand: connecting and disconnecting loads, taking into account current power consumption. Reducing peak power consumption by means of disconnecting unnecessary loads.
- Distributed measuring systems, connected via ModBus protocol with central data system.
- "All in one replacement" for more than 12 classical instruments (voltmeters, ampermeters, cos φ meters, etc.)

Standards:

Static meters for active energy
IEC 62053-21:2003 Class 1
Static meters for reactive energy
IEC 62053-23:2003 Class 2

Technical specifications

Configuration:	3 voltage inputs, 3 current inputs
System:	single phase, 3-phase (3 or 4 wire unbalanced load)
Measuring principle:	4 quadrants, 10 periods, 128 scans/period
Display update:	1 update/s, harmonics 1 update/5 s
Direct connection of current inputs to standard CTs with 5 A output	
Wide voltage range from 0 V to 500 V	
Backlit LCD with 4 x 20 characters	
42 days of active and reactive energy logging	
RS 485 communication port	

General

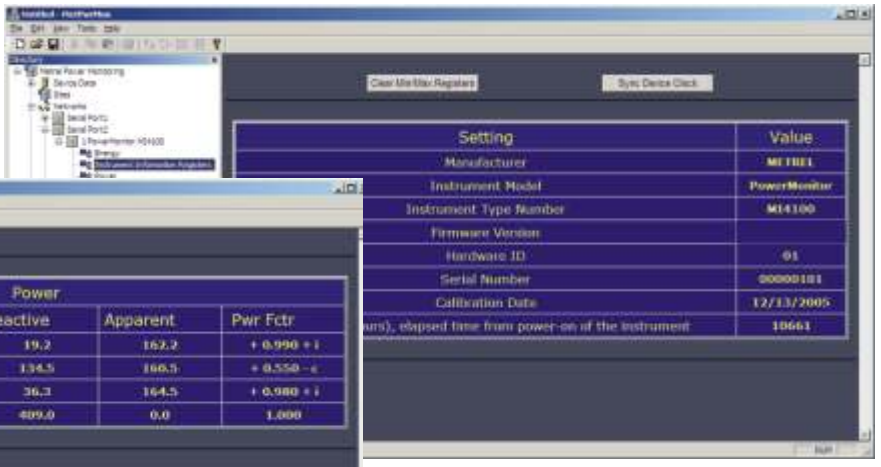
Power supply voltage:	180 V a.c. ÷ 260 V a.c., 50 Hz/60 Hz
Protection classification:	single insulation
Pollution degree:	3
Protection degree:	IP 40
Overvoltage category:	CAT III 600 V/CAT IV 300 V
Load:	5 VA max.
Dimensions (w x h x d):	96 x 96 x 100 mm (without screw adapters)
Dimensions (w x h x d):	108 x 96 x 100 mm (with screw adapters)
Standards applied:	EN61010-1, EN 61326
Weight:	0.55 kg
Reference temperature range:	0 °C +40 °C
Reference humidity range:	30 %RH 75 %RH, non-condensing
Working temperature range:	-10 °C +50 °C
Maximum relative humidity:	95 %RH (0 °C +40 °C), non-condensing
Temperature range:	-10 °C +70 °C
Maximum relative humidity:	90 %RH (-10 °C +40 °C)
	70 %RH (+40 °C +70 °C)

MEASURES	L_1 - N	L_2 - N	L_3 - N	L_1 - L_1	L_2 - L_2	L_3 - L_3	TOTAL	LOGGER $_{total}$
V	✓	✓	✓	✓	✓	✓		
Ucf	✓	✓	✓	✓	✓	✓		
A	✓	✓	✓	✓	✓	✓		
Icf	✓	✓	✓	✓	✓	✓		
Uthd	✓	✓	✓	✓	✓	✓		
Ithd	✓	✓	✓	✓	✓	✓		
kW	✓	✓	✓				✓	✓ **
kVA	✓	✓	✓				✓	✓ **
kVAR	✓	✓	✓				✓	✓ **
Pf 4 quadrant	✓	✓	✓				✓	✓ **
*kWh +							✓	✓ **
*kWh -							✓	✓ **
*kVARh +							✓	✓ **
*kVARh -							✓	✓ **
Hz	✓							
U harmonics	✓	✓	✓	✓	✓	✓		
I harmonics	✓	✓	✓	✓	✓	✓		

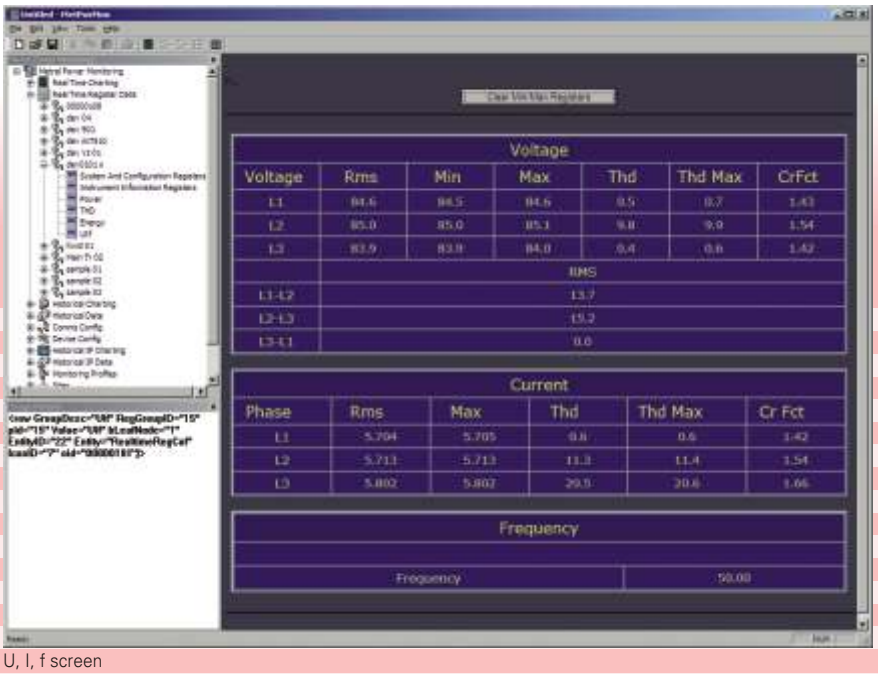
*- support 4 tariffs
** - via MODBUS only
U, I harmonics: up to 31st harmonics

PC SW Power Monitoring

Instrument Information Registers Clear Min/Max and Sync Device Clock command buttons are available on this screen.



Example of Power Live screen



U, I, f screen

Ordering information

Standard Set Part No. **MI 4100**

- Instrument Power Monitor
- Instruction manual
- Product verification data

Optional accessories

A 1222	- ADAM-4570-AE	RS 232/422/485
A 1223	- ADAM-4561-AE	USB to RS 232/422/485
A 1224	- ADAM-4520-D2E	RS 232, RS 485

Power Monitor MI 4100

Metrel Power Monitoring System Solution

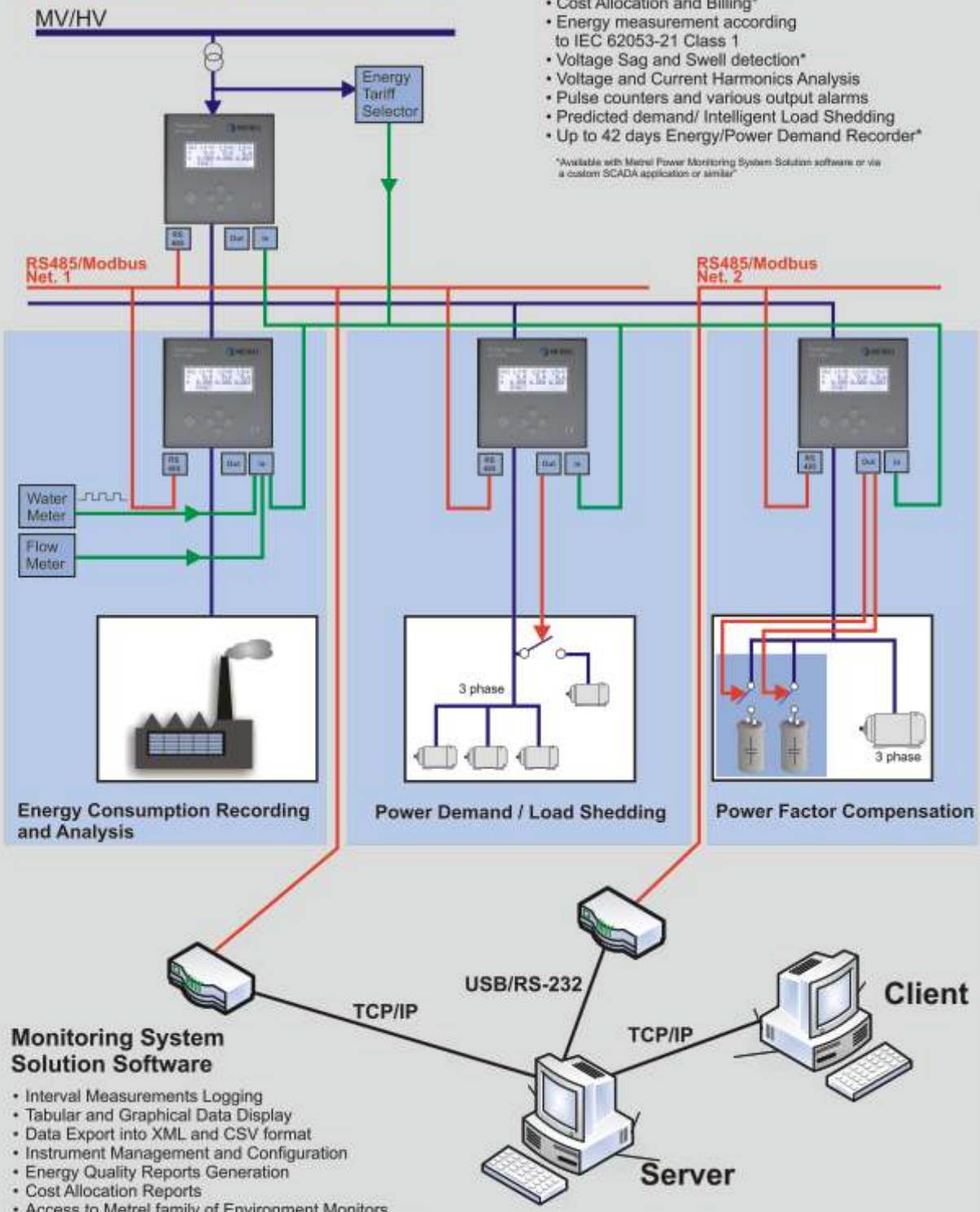
Applications

- **Replace a Group of Panel Meters**
- **Energy Consumption Recording and Analysis**
- **Load Shedding or Compensation to Avoid Penalties**
- **Power Factor Compensation**
- **Switchboard Measurement**
- **Power Quality Monitoring**
- **Cost Allocation and Billing for Electrical and Thermal Energy, Water, Gas, etc...**
- **Alarms for Malfunctions Identification**

Power Monitor MI 4100

- Accurate three phase measurements of more than 300 parameters on voltage, current and power (RMS, CF, PF, THD, P, Q, S, harmonics, etc..)
- 4-Quadrant Power Metering
- Power and Current Demand
- 4-Tariff 4-Quadrant Energy Metering
- Phase and Total Power Metering
- Total Power Metering
- Cost Allocation and Billing*
- Energy measurement according to IEC 62053-21 Class 1
- Voltage Sag and Swell detection*
- Voltage and Current Harmonics Analysis
- Pulse counters and various output alarms
- Predicted demand/ Intelligent Load Shedding
- Up to 42 days Energy/Power Demand Recorder*

*Available with Metrel Power Monitoring System Solution software or via a custom SCADA application or similar



Monitoring System Solution Software

- Interval Measurements Logging
- Tabular and Graphical Data Display
- Data Export into XML and CSV format
- Instrument Management and Configuration
- Energy Quality Reports Generation
- Cost Allocation Reports
- Access to Metrel family of Environment Monitors
- Optionally Read Data from a Generic Modbus Device

VoltScanner

A "Plug and measure" solution to analyse the quality of the line voltage in accordance with EN 50160

VoltScanner is a simple instrument, designed to record voltage characteristics at the customers supply terminals in public electricity distribution systems, according to the EN 50160 standard.

It records voltage dips, swells, transient overvoltages, frequency variations and supply interruptions.

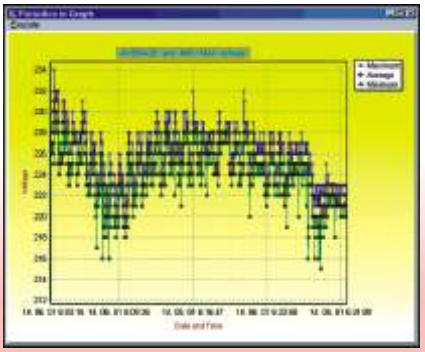
- **A flashing LED indicates that events have been captured**
- **Memory capacity of up to 3500 events**

Operating procedure

- **Set-up limit values**
  - – Custom or EN 50160 auto-mode
- **Plug-in**
- **Measuring & Recording**
  - **Events mode**
    - – Dips/Sags, Swells
    - – Voltage interruptions
    - – Frequency fluctuations
    - – Transients overvoltage
  - **Periodics mode**
    - – Power frequency
    - – Supply voltage
    - – EN 50160 auto-mode
- **Downloading**
- **Analysis**
  - Periodics (max., min., or average values) - table or graph.
  - Statistics of all the events by character, magnitude, time stamp.
- **Detailed reports and graphs**

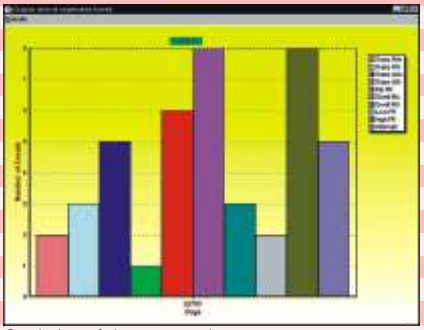
ScanLink

ScanLink Windows software for analysing and print-outs with a complete history of captured events in a tabelaric or graphic form (statistics). By analysing periodics it enables review of voltage quality against the set limits (Custom or EN 50160 auto-mode).



Periodics analysis of voltage variation for the past 3 weeks

Set-up of event recording or periodics recording mode



Statistics of the captured events

Technical specification

Measurement

Phase to Neutral

Range	Accuracy	Resolution
90 to 265 V	± 2 V of reading + 2 %	1 V

Neutral to Ground

Range	Accuracy	Resolution
0 to 155 V	± 2 V of reading + 2 %	1 V

Frequency

Range	Accuracy	Resolution
47–52 Hz,	± 0.1 Hz	0.1 Hz
57–62 Hz	± 0.1 Hz	0.1 Hz

Transients

Range	Accuracy	Resolution
50 to 2600 V	± 10 %	5 V

Minimum width: 1 µs

General

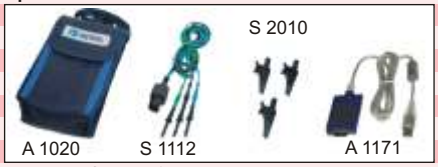
- – Nominal Supply Voltage: 230 V or 120 V
- – Nominal Frequency: 50/60 Hz
- – Communication: RS 232 serial interface, fully opto isolated, 9 pin D-type connector
- – Memory: 32 kB, 3500 events
- – Battery-rechargeable NiMH 1.2 V, 4 pcs
- –Overvoltage category: CAT III 300 V

Ordering information

Standard Set: Part No. **MI 2130**

- Instrument VoltScanner
- Mains measuring cable, 1.5 m
- Battery-rechargeable NiMH 1.2 V, 4 pcs
- PC SW ScanLink
- RS 232 cable
- Instruction manual
- Product verification data

Optional accessories



A 1020 - Small soft carrying bag
A 1171 - USB/RS232 converter with 1 m fixed cable
S 1112 - Universal test cable 3 x1.5 m with 3 safety test tips
S 2010 - Alligator clips, 3 pcs

Power Simulator set

One phase, multi-purpose power simulator for simulating typical situations in low voltage power supply systems.

- Excellent tool for training and demonstration purposes.
- Simulation of transients, inrush currents, flickers, harmonics, power supply outages, etc.
- Load character adjustment, adjustable current and voltage level with a simulation of 22 different faulty conditions.

Main features

The MI 2191 one phase power simulator, simulates typical voltage and current shapes including:

- Voltage and Current Harmonics
- Flickers
- Start-up events, Inrushes
- Transients
- Dips and Sags
- Voltage interruptions
- Different load conditions, etc.

Voltage events can be simulated in single, periodic or random mode. PC upgradeable.

Operation

The following functions can be performed:

- different disturbance signals can be added to an ideal sinusoidal voltage and current waveform.
- the amplitude and frequency of the voltage and current can be varied.

Voltage events can be simulated during the output sequence. The events can be added manually (single, repeated or random).

Applicable standards

Power Simulator is designed in accordance with the following European standards:
EN 61010-1
Electromagnetic compatibility (noise and immunity):
EN/IEC 61326-1

Ordering Information

Standard Set Part No. **MI 2191**

- Instrument Power Simulator
- Short form quick guide plastic cards
- Power cord
- Current measuring cable
- Instruction manual
- Handbook "Modern Power Quality Measurement Techniques" on CD
- Product verification data

Technical specifications

Voltage output	
Port:	L1
Output voltage (peak to peak):	-400 to 400 V, arbitrary, AC type
Max.output power:	3W
Output resistance:	ca. 1,8 kΩ
Frequency:	50/60 Hz
Resolution:	8 bits
Accuracy:	±(5 %+10 V)
Current output	
Port:	I1
Output (peak to peak) voltage:	-2 to 2 V, arbitrary
Output resistance:	ca. 320 Ω
Frequency:	50/60 Hz
Resolution:	8 bits
Accuracy:	±(5 %+0.05 V)

General	
Power supply:	AC 115 V / 230 V, 50 Hz / 60 Hz, 12 VA, contact METREL for the selected option
Optional:	110 V version
Fuses:	F1: T200mA 250 V 5x20 - POWER SUPPLY PROTECTION F2: T1000mA 250 V 5x20 VOLTAGE OUTPUT SHORT CIRCUIT PROTECTION !
Display:	custom type
Connection to PC:	serial port RS232
Overvoltage category:	CAT II, 300 V
Pollution degree:	2
Temperature range:	0 - 40 ºC
Maximum humidity:	85% RH
Dimensions (w x h x l):	265 x 110 x 185 mm
Mass (without accessories):	2.4 kg

Power Quality Accessories Application Guide

Seamless integration of measurement equipment with the analysed object becomes of paramount importance and serves as a great help for technicians on site. Therefore a wide selection of accessories for the entire range of Metrel's digital Power Quality Analysers is available. Recommended use for every product is described in the following guidelines.
More detailed specifications of the products offered can be supplied on request.

Current clamps, transformers and adapters

This range of products extends the versatility of the Power Quality Analyser family and provides safe, accurate and non-intrusive measurements in applications which cannot be accessed with conventional cable connections.

A 1033 - Current clamps 1000 A / 1 V

Measuring range: 0,2 A to 1200 A AC
Frequency range: 40 Hz to 5 kHz
Voltage output: 1 mV/A
Accuracy in %: ≤3 at 0.110 A; ≤3 at 10 A; ≤2 at 20 A; ≤1,1 at 200 A; ≤1 at 1000 A; ≤1 at 1200 A
Overvoltage category: 600 V, CAT III
Maximum conductor diameter: 51 mm
Maximum aperture: 55 mm

Typical applications
Designed for use in applications requiring measurement of current without interrupting the electric circuit.
Jaws can be snapped open, placed around the conductor and snapped closed to form a magnetic loop around the conductor.
Hint
If a clamp is snapped around both wires of a single-phase electric network, a leakage current to ground will be measured.
Availability
3 pieces are supplied in the standard set.

A 1120 - Three-phase flex current clamp 3000 A / 1 V

Maximum measuring current: 30 A / 300 A / 3000 A AC
Frequency range: 2 Hz to 5 kHz
Voltage output: 33,3 mV/A; 3,33 mV/A; 0,33 mV/A
Accuracy: +/- 1% of reading in reference conditions
Overvoltage category: 600 V, CAT III
Length of the measuring head: 450 mm
Maximum head capacity: 130 mm

Typical applications
Due to their flexibility these current transducers will accommodate conductors of various shapes and dimensions. This set is suitable for 3-phase current measurements up to 3000 A. Typically used in power quality measurements on larger objects (transformers, sub-stations).
Hint
With proper selection of the measuring current range the accuracy can be considerably improved.
Availability
Available on request.

A 1099 - Single-phase flex current clamp 3000 A / 1 V

Maximum measuring current: 30 A / 300 A / 3000 A AC
Frequency range: 10 Hz to 20 kHz
Voltage output: 33.3 mV/A; 3.3 mV/A; 0.33 mV/A
Accuracy: 1% of range
Overvoltage category: 600 V, CAT III
Length of the measuring head: 600 mm
Maximum head capacity: 178 mm

Typical applications
Large capacity measuring head will accommodate conductors of various shapes and dimensions. This set is suitable for 1 or 3-phase current measurements up to 3000 A. For 3-phase measurements at least 3 pieces of A 1099 are required. With proper connection we can choose between 3-wire (3 x A 1099), 4-wire (3 x A 1099) or Aaron (2 x A 1099) power measurement.
Hint
With proper selection of the measuring current range the accuracy can be considerably improved.
Availability
Optional.

A 1069 - Mini current clamp 100 A / 1 V with A 1039 - Clamp Adapter

Maximum measuring current: 100 A AC
Frequency range: 40 Hz to 5 kHz
Voltage output: 10 mV/A
Accuracy in %: ±2% at 5 ÷ 10 A; ±1% at 10 ÷ 100 A
Overvoltage category: 600 V, CAT III
Maximum conductor diameter: 15 mm
Maximum aperture: 15 mm

Typical applications
Designed for use in applications requiring measurement of current without interrupting the electric circuit. Most frequently used in current and power measurements. Jaw dimensions make them suitable for measurements on round conductors with a diameter up to 15 mm on larger single phase systems, telecommunication applications, switch boxes. For 3-phase measurements at least two clamps (Aaron connection) are required.Standardized voltage output allows the transformer to be connected to other instruments with 1 V AC input.
Note
For connecting the current transformer to an instrument, A 1039 Clamp Adapter has to be purchased.
Availability
Optional.

A 1122 - Mini current clamp 5 A / 1 V with A 1039 - Clamp Adapter

Maximum measuring current: 5 A AC
Frequency range: 40 Hz to 5 kHz
Voltage output: 200 mV/A
Accuracy in %: ±3% at 0 ÷ 5 A
Overvoltage category: 600 V, CAT III
Maximum conductor diameter: 15 mm
Maximum aperture: 15 mm

Typical applications
These clamps feature similar properties as the A 1069. Jaw dimensions make them suitable for measurements on round conductors with a diameter up to 15 mm. Nominal current range up to 5 A AC is ideal for measurements in IT environments, on smaller electronicall
Availability
Optional.

A 1037 - Three-phase current transformer 5 A/1V

Maximum measuring current: 5 A AC
Frequency range: 40 Hz to 5 kHz
Voltage output: 200 mV/A
Accuracy in %: ±0,3 %
Overvoltage category: 600 V, CAT III

Typical applications
Normally used in power sub-stations with standard 5 A AC current output.
Typical applications include 3 phase power quality measurements.
In case standard current output is present, additional current clamps are not needed.
This set is especially helpful when performing long-term measurements because there is no need to break the electrical circuits.
Availability
Optional.

Connection cables and adapters

The introduced range of accessories will safely connect the Power Quality Analysers to the measured circuit. Although some of the presented items are not included in the standard set they can be ordered separately when the need occurs.

S 2014 - Safety Fuse Adapters

Overvoltage category: 600 V, CAT III
Nominal current: 20 A
Breaking capacity: 100 kA
∅4 mm safety connection

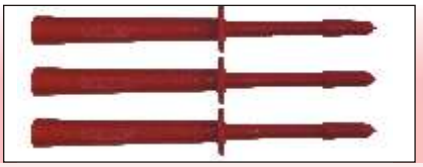
Typical applications
Designed for voltage measurements and for protection of electrical equipment as well as electricians in high energy LV systems.
The adapter can be equipped with an efficient low voltage fuse which reliably isolates the measuring circuit from the mains supply in the event of excessively high current load.
Availability
Optional.

S 2015 Safety flat clamps

Overvoltage category: 600 V, CAT III
Nominal current: 5 A
Maximum thickness of flat conductor bar: 30 mm
∅4 mm safety connection

Typical applications
Foreseen for voltage measurements. Clamps provide reliable grip for safe measurements.
With adjustable stop they are particularly useful when making connections on bus bars and other large sized conductors which cannot be embraced with crocodile clips.
Standardized 4 mm safety connection makes them suitable for use with other instruments.
Availability
Optional.
- 4 pcs included in the Standard set for MI 2292.

Test Tips



- Overvoltage category: 1000 V, CAT III
- ∅ 4 mm connection.

Typical applications
∅ 4 mm safety connection of the tips makes them suitable for performing measurements in mains outlets or quick, indicative voltage measurements.
Availability
3 pieces included in the standard set.

Voltage measurement cables

- Overvoltage category: 1000 V, CAT III
- ∅ 4 mm connection.

Typical applications
Thanks to ∅4 mm safety connection which fits the entire range of accessories supplied in the Power Quality set, the cables can be used in a vast number of different applications.
Availability
3 pieces included in the Standard set.

S 2010 - Alligator Clips

- Overvoltage category: 1000 V, CAT III
- ∅ 4 mm connection.

Typical applications
Commonly used in voltage measurements. They feature firm, reliable grip for safe measurements.
Standardized 4 mm safety connection makes them suitable for use with other instruments.
Availability
3 pieces included in the Standard set.

A 1171 - USB/RS232 converter with 1 m fixed cable

- RS 232 USB Cable Style Converter with 1m fixed cable
- User manual and Installation guide
- Driver and utility CD

Cable can be used to connect instruments with RS 232 port on USB port on a PC. Enhanced converter is able to support RS232 Baud rates of up to 460k Baud.

Communication accessories

Measurements on several remote locations simultaneously - with the possibility to control Power Quality measuring equipment from a single location - become true with the following communication equipment.

A 1100 - Modem ST

A 1101 - Modem GSM

A 1124 - Modem Entrance Key

Typical applications
Using modem connection between the instrument and the PC enables the following tasks to be completed:
- Remote programming of the instrument via PC.
- Downloading recorded data via PC from a remote location.
- Receiving SMS alarms (task completed, full memory, 20 % of memory is free, 50 % of memory is free, recording is finished).
- Clear memory.

Connectivity
Communication modems come installed on the instrument's and the PC side.
The following combinations are possible:
the PC side can be equipped either with standard analog A 1100 Modem ST or with A 1101 Modem GSM.
The instrument can either have standard analog external modem A 1100 Modem ST or A 1101 Modem GSM.
If an analog phone line is available, A 1100 Modem ST is used. Otherwise, A 1101 Modem GSM has to be used.
A 1124 Modem Entrace Key activates access to the modem support.
Availability
- Modems are supplied optionally.
- A 1124 Modem entrance Key is included in the Standard set of MI 2292 Power Quality Analyser Plus.
- A 1124 Modem Entrance Key for MI 2092 is available optionally.

Short Glossary

Harmonics are voltages or currents with a frequency that is an integral multiple of the fundamental supply frequency.

Interharmonics are voltages or currents with a frequency that is a non-integral multiple of the fundamental supply frequency. Interharmonics, always present in the power system, have recently become of more importance since the widespread use of power electronic systems results in an increase of their magnitude.

Voltage Dips is a short-term reduction in, or complete loss of, RMS voltage. It is specified in terms of duration and retained voltage, usually expressed as the percentage of nominal RMS voltage remaining at the lowest point during the voltage dip. A voltage dip means that the required energy is not being delivered to the load and this can have serious consequences depending on the type of load involved.

Voltage swell is a temporary increase of the voltage at a point in the electrical system above a threshold.

Flicker is the impression of unsteadiness of visual sensation induced by a light stimulus, the luminance or spectral distribution of which fluctuates with time. Usually it applies to cyclic variation of light intensity of lamps caused by fluctuation of the supply voltage.

Periodics is the base for power quality measurements. In fact the EN50160 measurement is a periodic measurement with the recording parameters set to EN50160 standard requirements. Measuring period is the time period between the beginning and end of the measurement.

Waveform is defined as a steady-state deviation from an ideal sine wave of power frequency principally characterized by the spectral content of the deviation.

Fast logging is a measurement similar to a waveform recording but instead of storing 64 points in a wave half-period, only the RMS value of a particular half-period is saved.

Transients are sudden changes of steady state voltage, current or load. These sudden changes are mostly found as the result of the operation of switching devices. Transients can cause oscillatory ringing. Filters are used to prevent these ringing oscillations from affecting delicate equipment.

EN 50160 was approved by the European Committee for Electrotehnical Standardization (CENELEC) in 1994. EN 50160 specifies voltage characteristics at the customers supply terminals or in public LV and MV electricity distribution systems under normal operating conditions.

Note! Photographs in this catalogue may slightly differ from the instruments at the time of delivery.
Subject to technical change without notice.

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